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NASA TECH BRIEF

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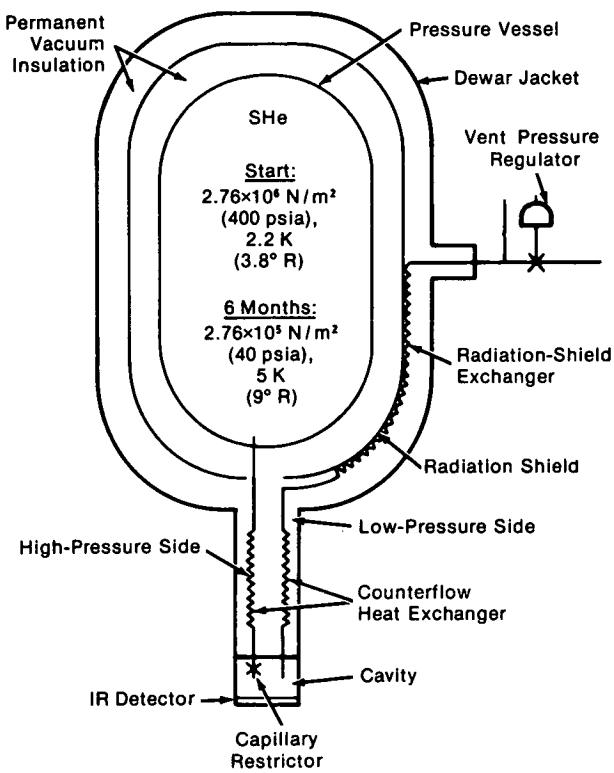
A Two-Degree Kelvin Refrigerator

A new open-cycle cryogenic refrigerator maintains a temperature as low as 2 K for periods of up to 6 months. Designed to cool an infrared (IR) detector, the refrigerator can be used in cooling other small devices, e.g., Josephson-junction devices, magnetic bubble domains, and superconducting devices.



Refrigerator Schematic

The refrigerator is made up of a high-vacuum superinsulated Dewar with gas-cooled radiation shields, as shown in the illustration. The Dewar is filled with supercritical helium (SHe) to a pressure of 2.76×10^6 N/m^2 (400 psia); the temperature of the SHe is above 2.2 K.

The SHe flows through a counterflow heat exchanger and discharges through a capillary tube restrictor with an inside diameter of 0.03 mm (0.001 in.). At the end of this capillary, the helium undergoes a Joule-Thomson expansion into a low-pressure cavity (approximately 30 torr) to which the IR detector is connected. The expansion produces a mixture of gas and superfluid helium droplets. The droplets of He II percipitate onto the cavity wall where they evaporate, thus removing heat at 2 K or below from the detector. detector.

The detector is thus cooled by the evaporating film of He II in the matrix. The gaseous helium (GHe) produced by this evaporation, along with the gas produced by the expansion, flows out through the low-pressure side of the counterflow heat exchanger. It removes heat from the incoming stream of SHe.

After leaving the heat exchanger, the GHe flows through the radiation shield of the Dewar, removing incoming radiation heat. From the shield the GHe flows through a pressure regulator which regulates vapor pressure in the detector-mount cavity, thus controlling the detector-mount temperature. The gas is then vented overboard through spacecraft attitude-control jets. This clean, noncondensable gas jet is the noncontaminating, propulsive attitude-control system.

(continued overleaf)

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Reference: TSP75-10181

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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Categories: 03 (Physical Sciences)
06 (Mechanics)
01 (Electronics - Components and Circuitry)